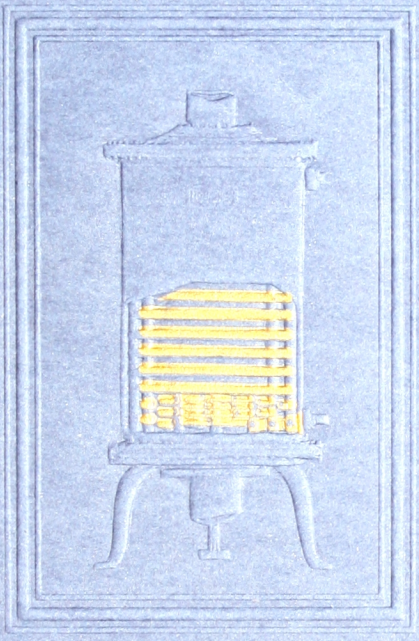
Heating Feed Water with Exhaust Steam



NATIONAL
FEED WATER HEATERS

CATALOG
FIFTY-ONE

Heating Feed Water with Exhaust Steam

NATIONAL
FEED WATER HEATERS

INTRODUCTION

No matter how you go about it—
Heat the Feed Water.

Even if you have other use for exhaust steam—
Heat the Feed Water.

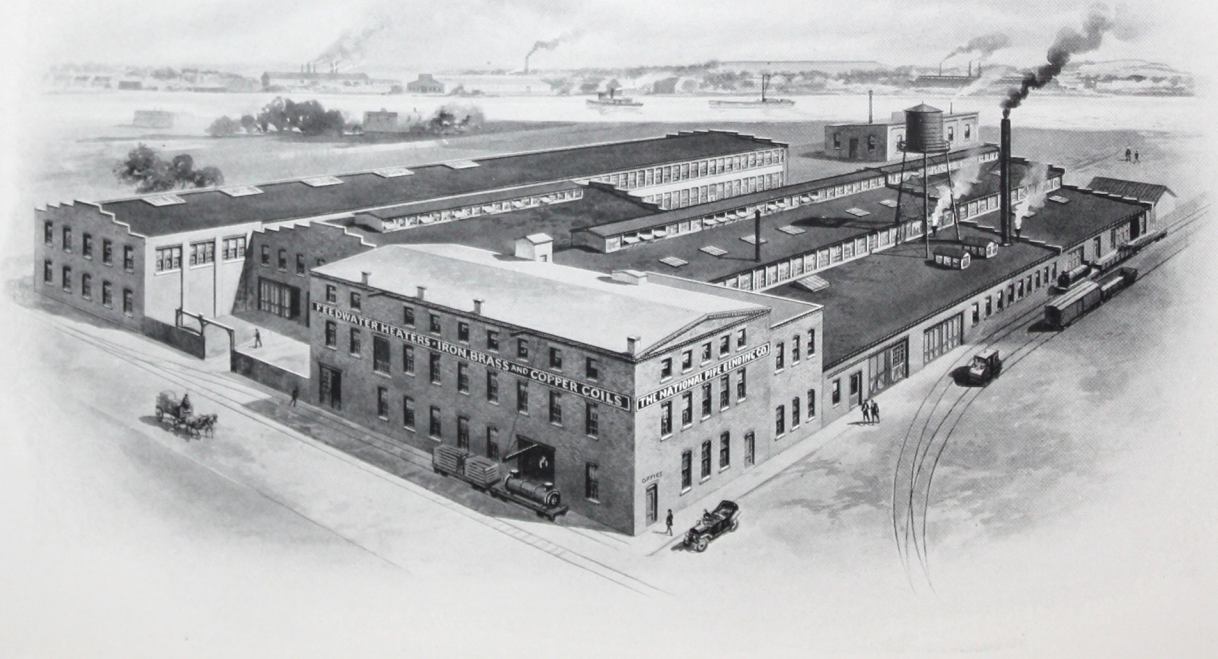
Use live steam if you must, but—
Heat the Feed Water.

To relieve the boiler of contraction strains—
Heat the Feed Water.

To get more steam from your boiler—
Heat the Feed Water.

To save the waste heat in exhaust steam—
Heat the Feed Water.

No matter what else you do—for your boiler's sake—Heat the Feed Water.



FACTORY OF THE NATIONAL PIPE BENDING CO.

Heating Feed Water With Exhaust Steam

NATIONAL

FEED WATER HEATERS

CLOSED TYPE

CATALOG FIFTY-ONE

THE NATIONAL PIPE BENDING CO.
NEW HAVEN, CONNECTICUT
INCORPORATED 1883

149 Broadway
New York

54 High Street
Boston

HEATING FEED WATER

The fuel saved is the most easily measured gain from heating feed water with exhaust steam. This is a definite saving. Expressed in terms of coal used, it amounts to about one per cent. for every eleven degrees added to the feed water temperature.

Saving in Fuel

Or, looking at it in another way, throwing away exhaust steam, which contains about 85 per cent. of the heat in live steam, and feeding cold water is a distinct and calculable loss because fuel must be consumed in heating the water up to the temperature at which vaporization takes place.

When power plant conditions are known, the percentage of fuel saved can be foretold with considerable accuracy by using this table:—

Percentage of Saving for Each Degree of Increase in Temperature of Feed Water

Initial Temp. of Feed Water Fahr.	Boiler Pressure in pounds above Atmosphere								
	40	60	80	100	120	140	160	180	200
32°	.0855	.0851	.0847	.0844	.0841	.0839	.0837	.0835	.0833
40	.0861	.0856	.0853	.0850	.0847	.0845	.0843	.0841	.0839
50	.0868	.0864	.0860	.0857	.0854	.0852	.0850	.0848	.0846
60	.0876	.0872	.0867	.0864	.0862	.0859	.0856	.0855	.0853
70	.0884	.0879	.0875	.0872	.0869	.0867	.0864	.0862	.0860
80	.0891	.0887	.0883	.0879	.0877	.0874	.0872	.0870	.0868
90	.0900	.0895	.0888	.0887	.0884	.0883	.0879	.0877	.0875
100	.0908	.0903	.0899	.0895	.0892	.0890	.0887	.0885	.0883
110	.0916	.0911	.0907	.0903	.0900	.0898	.0895	.0893	.0891
120	.0925	.0919	.0915	.0911	.0908	.0906	.0903	.0901	.0899
130	.0934	.0928	.0924	.0920	.0917	.0914	.0912	.0909	.0907

Find the factor which corresponds to the temperature of the cold water and boiler pressure, then multiply by the increase in water temperature. The product will be the percentage saved.

Example: Initial temperature of feed water, 60 degrees. Boiler pressure, 140 pounds. Factor, .0859. Heating to 210 degrees would be an increase of 210 — 60 = 150 degrees; and .0859 × 150 = 12.885 or 12.88 per cent.

What the saving means in dollars is easily found as follows: Assume

Non-condensing plant of 400 horse power.
Cold water temperature, 70 degrees.
Boiler pressure, 140 pounds.
Cost of coal, $3.50 per ton at plant.
Coal used per day, 6 tons.
Cost of coal per day, $21.00.

Saving in Money

From the table we find the factor to be .0867, and, as the feed water can be raised 210—70 = 140 degrees, the percentage saved would be .0867 × 140 = 12.138 or 12.14 per cent. The coal saved per day would amount to $2.55, or $765 per year of 300 days.

INCREASED BOILER CAPACITY

Heater does part of the Boiler's Work

With the same quantity of coal burned, a considerable increase in boiler output is assured by heating the feed water with exhaust steam, because the water comes to the boiler with a part of its heat supplied and more water will be evaporated with the same amount of heat transmitted through the boiler heating surfaces.

With an initial temperature of 60 degrees and a boiler pressure of 120 pounds, the total heat that must be supplied is 1191.6 — 28 = 1163.6 B. t. u. (steam tables in any Engineering Handbook are based on a temperature of 32 degrees; and 60 — 32 = 28). If, now, the feed water temperature is raised to 210 degrees or through 150 degrees, many more pounds of water will be evaporated.

The total heat required to convert water at 210 degrees into steam at 120 pounds is 1191.6 — 178 = 1013.6 B. t. u. per pound, 1013.6 B. t. u. instead of 1163.6 B. t. u., or 1163.6 — 1013.6 = 150.0 B. t. u. are available for additional evaporation or 14.8 per cent. increase in capacity with the same amount of fuel.

Per cent. increase in capacity

REDUCED BOILER STRAINS

Good service and long service cannot be had from any boiler supplied with cold feed water. Sudden, violent strains always follow when cold water strikes hot plates—riveting is loosened, and plates and tubes injured. Furthermore, the strains are local, and, as they are also unequal in plates or tubes running in the same direction, the damage is pronounced.

Damage to Boiler Plates

The advantages of relieving boilers of these violent strains are not measurable, but the saving in wear and tear is very marked, as any engineer will admit.

ADVANTAGES OF THE CLOSED HEATER

Quality of Feed Water

The operating conditions, especially the quality of the water available for the boilers, usually decide the type of feed water heater to be used. With water reasonably free from those substances which form scale or corrode steel, the closed heater is the one to use. That it meets all requirements under such feed water conditions is proved by the mere fact that more than three and a quarter millions of horse power of "Nationals" have been installed.

No Oil in Boiler

The closed heater keeps the feed water entirely separate from the exhaust steam,—there's no chance for them to mingle,—hence no oil can enter the boiler. Even if no oil separator is used, not a drop of oil will contaminate the feed water. But it is well to install an oil separator with a closed heater, so that the condensation from the heater, together with all drips from the heating system, may be returned to the boiler.

Danger from Oil in Boilers

The importance of keeping oil out of boilers is seldom, if ever, overestimated. Oil not only causes overheating of plates and bagging in shells and drums, but also insulates the heating surfaces, hindering the transmission of heat to a greater extent than does scale. Still further, oil decomposed by high temperature forms acids which attack iron and steel.

In the closed heater of the water tube type—water inside the tubing and steam surrounding it—the feed water cannot come in contact with

iron or steel; for this reason the water tube type is superior to the steam tube heater. Still further, greater capacity and efficiency can be had from the water tube heater because of the greater velocity of water within the tubing which causes a more rapid transfer of heat.

Water Tube vs. Steam Tube Heaters

The National Feed Water Heater coil is a continuous brass or copper coil, seamless, without inside joints. It has no straight tubes to expand unequally, work loose, and leak. The National coil is also a spring, giving abundant flexibility.

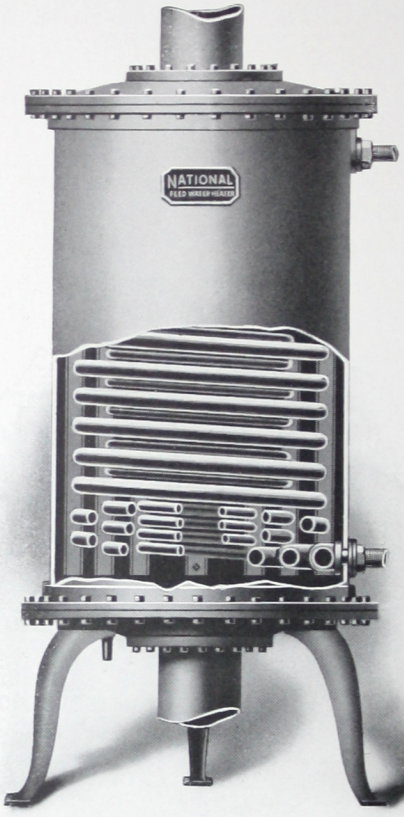
National Seamless Tubing

The efficiency of the National heater is in itself very high because brass and copper transmit heat more quickly than any other metal used commercially, and 500 times as fast as water. Brass or copper tubing is so strong that it can be made thin when the coiling of the tubing is done with the skill and care that is constantly exercised in the making of "National" coils.

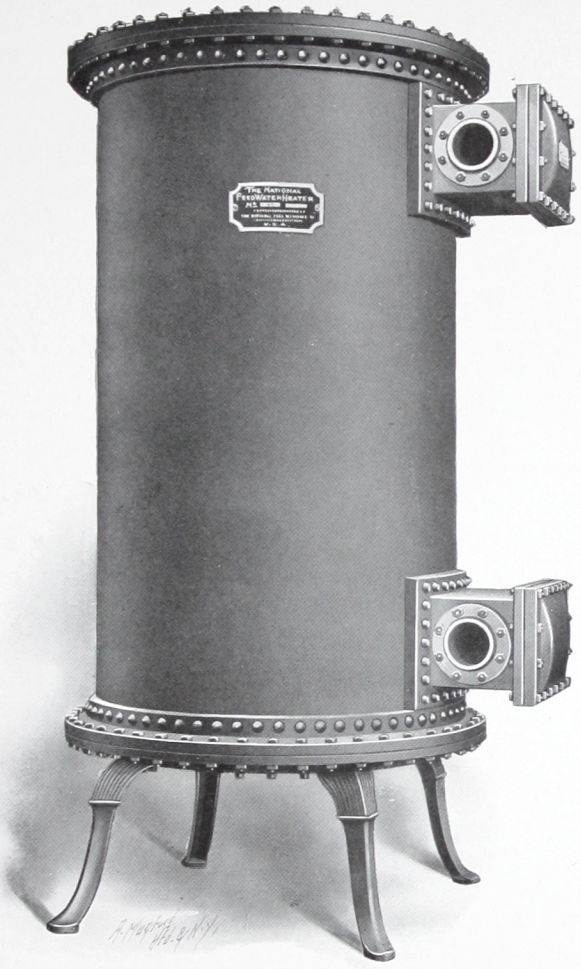
Efficiency of Coil Heater

The National closed heater presents the advantage of feeding the water at the maximum temperature of the heater: the water goes direct to the boiler, it is not cooled by being picked up by a pump. Furthermore the feed pump handles cold water instead of hot water with its vapors, as in the case of an open heater.

Water not cooled by Pump



NATIONAL
FEED WATER HEATER
Inside Manifold Type



NATIONAL
FEED WATER HEATER
Outside Header Type

THE NATIONAL HEATER

Simplicity

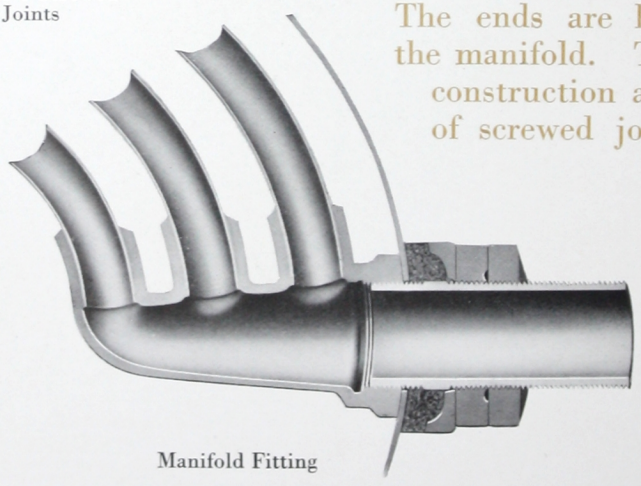
The National Feed Water Heater is very simple, it is free from complications. It is made up of a coil of seamless drawn brass or copper tubing within a vertical containing shell. Openings are provided for getting steam into and out of the shell and suitable connections for the water to flow through the coil.

Multi-coils

To handle a large quantity of water and yet have the heater of relatively small size, several coils (two to fourteen) are put into the shell. This multiplicity of coils divides the water into more streams, so that the large quantity heats quickly, but it does not add complications. The several coils require more careful bracing, and a manifold fitting is necessary to bring the ends of the coils into a common header to insure even flow through all of them, but we have taken care of these things.

No Screwed Joints

There are no screwed or soldered joints in the National heater coils; the tubing is seamless drawn with brazed joints. The ends are brazed into the manifold. This careful construction and absence of screwed joints insure



Manifold Fitting

absolute tightness. The coils are tested to 600 pounds per square inch water pressure to insure safety even with the highest boiler pressures carried in the most up-to-date power plants.

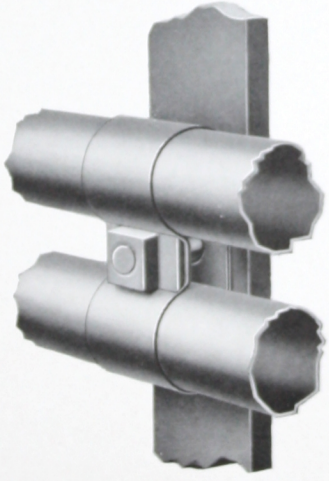
Safety

In the Inside Manifold type of heater, the ends of the coils are brazed into gun-metal manifolds. See page 10. This is the practice which has been followed for many years in building National heaters, for it has proven most successful—the coils remain perfectly tight.

Inside Manifold Type

In the Outside Header type, see pages 11 and 23, the ends of the coils are expanded into cast-iron feed boxes riveted to the shell. The feed connections can be made to either side of these external boxes, the side not used being blank flanged. A tight fitting cover plate, easily removed, gives ready access to the ends of all tubes, so that they are easily inspected. The smaller sizes, which are regularly made with inside manifolds, can be made in the Outside Header type if so specified.

Outside Header Type



Method of Bracing

The coils in the National heater are strapped and braced securely, yet

allowance is made for flexibility to take care of expansion and contraction with temperature changes. The style of bracing depends upon the number of coils, etc.

Bracing

The shell is of cast iron in the smaller sizes, as are also the heads, for this metal resists pitting.

Shell

Larger sizes usually have steel-plate shells riveted to cast-iron flanges, but the heads are of cast iron. Shells of cast iron may be had for the large sizes also at slight advance in cost. National heaters have large shells, with ample openings for exhaust steam to enter and leave.

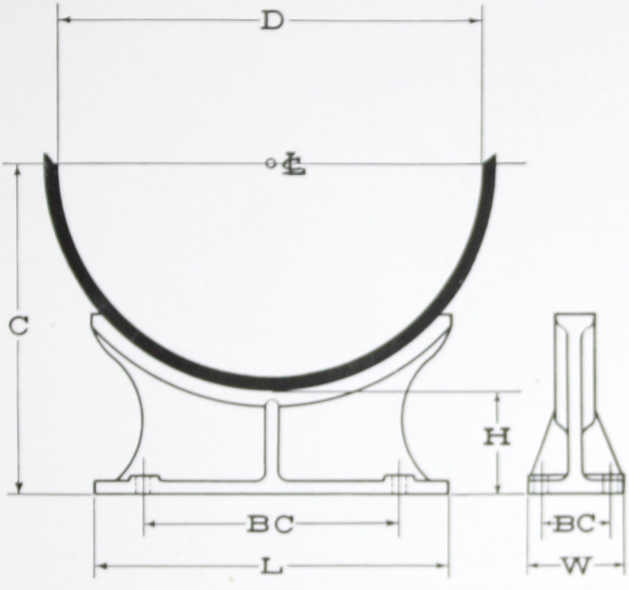
No increase in Back Pressure with a National

By thus providing a large area for the exhaust steam, the National overcomes the objection raised in connection with some closed heaters; namely, restricted passage for steam causing increase in back pressure. The area of the shell is six to ten times that of the exhaust pipe. The exhaust openings can be made of any desired size to suit the exhaust pipe from the engine.

Supports

National heaters, vertical, in sizes of more than eight square feet of heating surface, are provided with cast-iron legs. Horizontal heaters may be slung from overhead or supported on cradles of the dimensions shown on page 15.

DIMENSIONS
OF CRADLES FOR HORIZONTAL HEATERS.



D	H	C	L	W	BC
16	4	12½	16	5	10¾ x 3½
18	4	13½	16	5	10¾ x 3½
21½	5	16½	18	5	13 x 3½
29	5	19¾	20	6	14½ x 4½
35	5	22¾	21	6½	15 x 4½
48	6	30	26	8	20 x 5
57	6¼	35	26	8	20 x 5

NATIONAL FEED WATER HEATER IN CONDENSING PLANTS

No Increase of Back Pressure

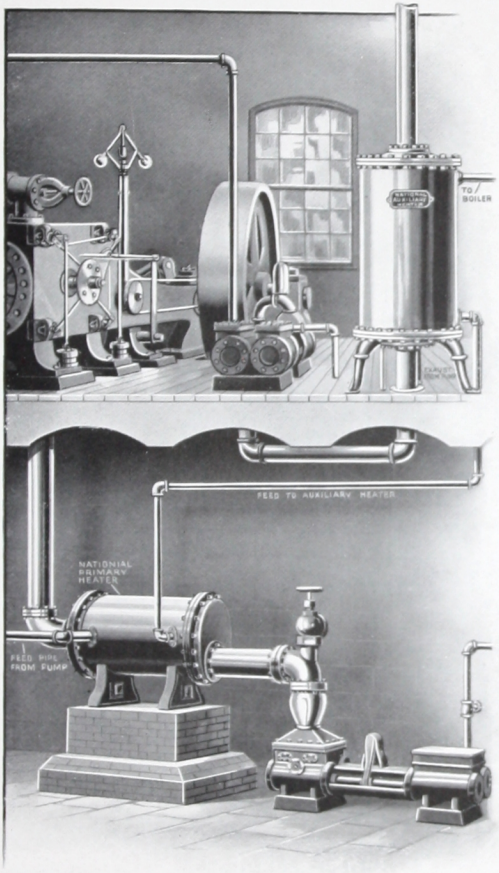
While the National closed heater is generally used in non-condensing steam plants, it is a source of great economy when used with a condenser, and fresh clean feed water can be had with an economy equal to that obtainable if the hot water discharged from air pumps is used for boiler feed. The reasons for this are not well understood among manufacturers and many owners of condensing steam plants, for the idea has gone abroad that a heater should not be used in such a plant. This is probably due to the fact that some forms of heater, having restricted passage for the steam, have been detrimental in that they have increased the back pressure, or, in other words, reduced the vacuum. This does not apply to the National, for the passage for the steam is very large and in no way hinders the flow. It may even be said that the heater, placed as it is between the engine cylinder and the condenser, itself acts as a condenser, for the tubing is filled with cold water. In this way it is of assistance to the condenser, increasing the vacuum.

Helps the Condenser

Primary and Secondary Heaters

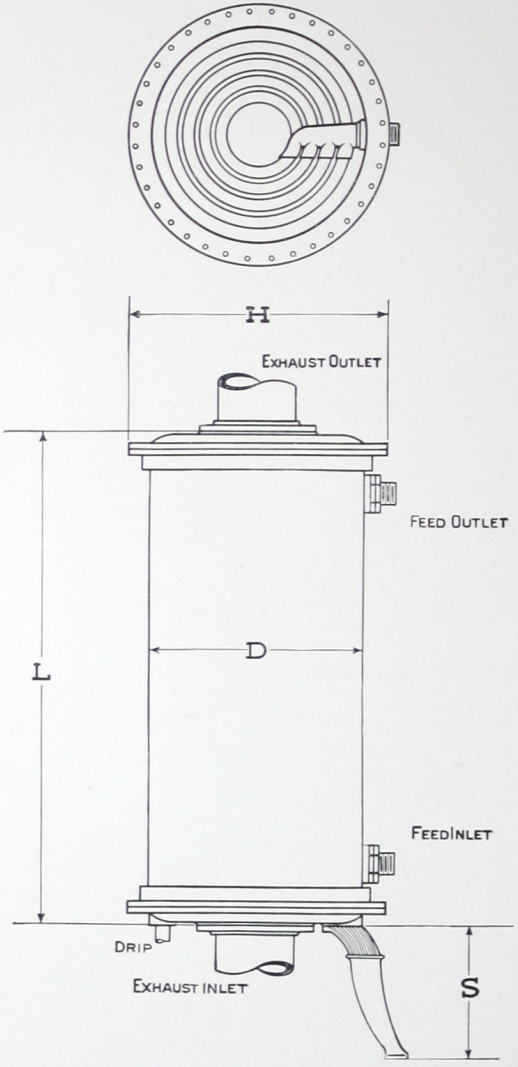
The advantages of using the heater in such a plant may be readily seen from the simple statement that with a vacuum of 26 inches a temperature of 126° in the feed water may be obtained. This means that usually there will be a saving of at least six per cent. over feeding cold water. If the idea is carried still

further, and an independent air pump is used and the feed water from the first heater passes through a second heater, it can be raised to more than 200°,—a result which is practically identical with that obtained in non-condensing plants.



CONDENSING PLANT

With Primary Heater between Engine and Condenser, and Auxiliary Heater using Exhaust from Feed-pump and Condenser



NATIONAL
FEED WATER HEATER
Inside Manifold Type

DIMENSIONS

INSIDE MANIFOLD TYPE

NATIONAL FEED WATER HEATERS.

No.	Shell Diameter D	Height L	Diameter H	Height of Legs S	Diameter of Feed Pipe	Diameter of Exhaust Pipe	Weight
05	5	10½	7		½	2	30
1	8	12	11		½	2	60
1½	8	17	11		½	2½	70
2	12	18	16		¾	2½	175
2½	14½	20	19		1	3	260
3	16	21½	20	12½	1	4	350
4	16	23	20	12½	1	4	370
5	16	28½	20	12½	1	4	400
6	16	33½	20	12½	1	4	450
8	16	38½	20	12½	1	4	475
10	18	40½	22	14	1¼	5	750
12	18	40½	22	14	1½	5	800
15	21½	45	26	15	1½	8	1100
20	21½	55	26	15	2	8	1275
25	21½	61	26	15	2	8	1450
30	21½	69	26	15	2	8	1600
40	29	70	36	18	2½	10	2175
50	29	84	36	18	2½	10	2375
60	35	79	42	22	3	12	3200
70	35	83	42	22	3	12	3300
80	35	88	42	22	3	12	3400
100	48	95	56	22	4	18	5200
125	48	111	56	22	4	18	5600
150	48	121	56	22	4	18	5900
200	57	116	66	22	5	18	9400
250	57	131	66	22	5	18	10500
300	57	148	66	22	5	24	11500
400	57	176	66	22	6	24	13500
500	57	203	66	22	8	24	15500

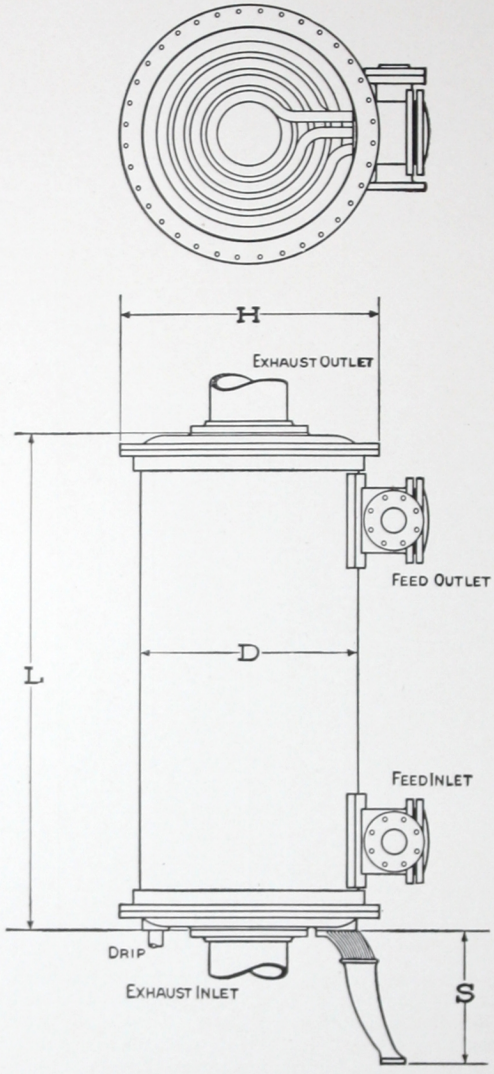
Sizes Nos. 1 to 2½ have exhaust inlet and outlet in top head.

Sizes No. 05, No. 3, and above have exhaust inlet in bottom and outlet in top heads, unless ordered different.

Size of exhaust can be varied to suit requirements.

Two or more exhausts in bottom head, if necessary.

Shells Nos. 05 to 30 are cast iron.



NATIONAL
FEED WATER HEATER
Outside Header Type

DIMENSIONS

OUTSIDE HEADER TYPE

NATIONAL FEED WATER HEATERS.

TYPE	A–3	B–3	B–4	D–4	B–5	D–5	E–5	D–6	E–6
Feed Connections	3	3	4	4	5	5	5	6	6
Shell Diameter (D)	29	35	35	48	35	48	57	48	57
Flange Diameter (H)	36	42	42	56	42	56	66	56	66
Surface Square Feet	Length over Heads (L) in Inches.								
150	72								
167	77								
175	82								
188	86								
200	91	72½	80½						
225		80½	86½						
233		80½	86½						
250		86½	91½						
267		91½	97½						
275		91½	97½						
300		97½	103½	73	103½	73			
333		103½	111½	81	111½	77			
350		111½	115½	81	115½	77			
367		115½	122½	85	122½	81			
375		115½	122½	85	122½	81			
400		122½	128½	91	128½	85	74	91	
417			134½	91	134½	85	74	97	
437			134½	97	134½	91	78	103	
450			140½	97	140½	91	78	103	
500			152½	103	152½	103	84	109	84
550			164½	109	164½	103	90	117	90
583			171½	117	171½	109	90	125	98
600			177½	117	177½	117	90	125	98
650				125		117	98	131	104
667				125		125	98	137	104
700				131		125	104	143	110
750						131	104	151	117
800						137	110	157	117
833						143	117	163	117
850						143	117	163	126
900						151	122	171	131
950						157	122	177	131
1000						163	126	190	138
1100							138	204	146
1167							146	218	158
1200							146	218	158
1300									171
1400									178
1500									191
Height of Legs (S)	18	22	22	22	22	22	22	22	22

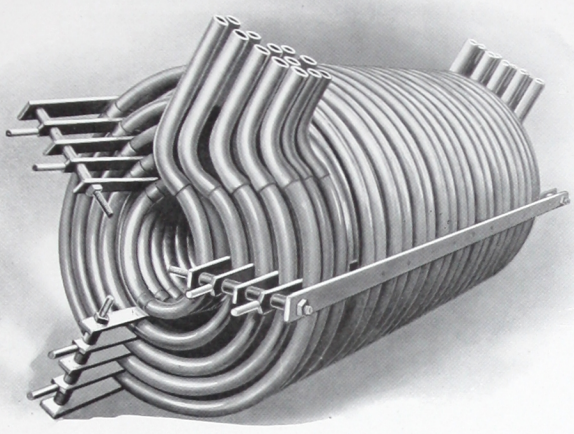
Exhaust Connections can be any Size Desired.

WEIGHTS

OUTSIDE HEADER TYPE

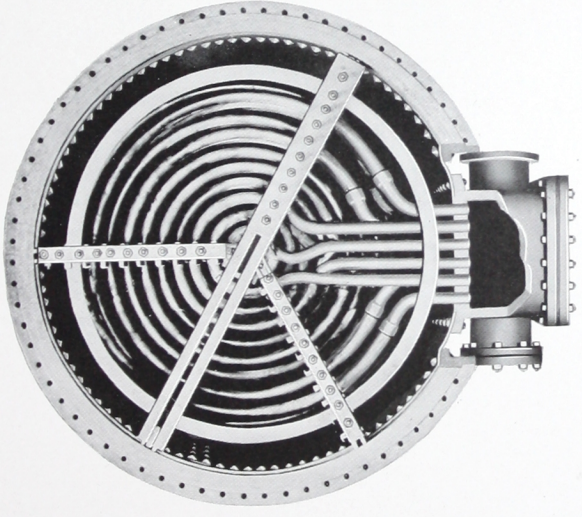
NATIONAL FEED WATER HEATERS.

TYPE	A–3	B–3	B–4	D–4	B–5	D–5	E–5	D–6	E–6
SURFACE	WEIGHT								
150	2800								
167	2900								
175	3000								
188	3100								
200	3150	3600	4100						
225		3650	4250						
233		3750	4300						
250		3950	4400						
267		4000	4550						
275		4050	4600						
300		4200	4750	5800	4950	6100			
333		4350	4950	6050	5200	6200			
350		4450	5050	6100	5300	6250			
367		4550	5150	6200	5400	6400			
375		4650	5200	6250	5500	6450			
400		4750	5400	6450	5600	6600	8450	6950	
417			5500	6550	5750	6650	8550	7100	
437			5600	6650	5800	6850	8650	7250	
450			5700	6750	6000	6900	8750	7300	
500			6100	7050	6250	7300	9000	7600	9300
550			6350	7200	6650	7400	9300	8000	9600
583			6550	7500	6850	7700	9400	8100	9900
600			6750	7600	6950	7900	9500	8150	9950
650				7850		8000	9850	8450	10250
667				7900		8150	9900	8950	10350
700				8150		8250	10350	9200	10550
750						8550	10450	9500	10900
800						8850	10850	9800	11000
833						9250	11100	9950	11500
850						9300	11200	10050	11850
900						9700	11400	10350	12150
950						9950	11600	10650	12250
1000						10150	11850	11100	12650
1100							12550	11700	13200
1167							12900	12150	13750
1200							13000	12250	13850
1300									14450
1400									15000
1500									15650



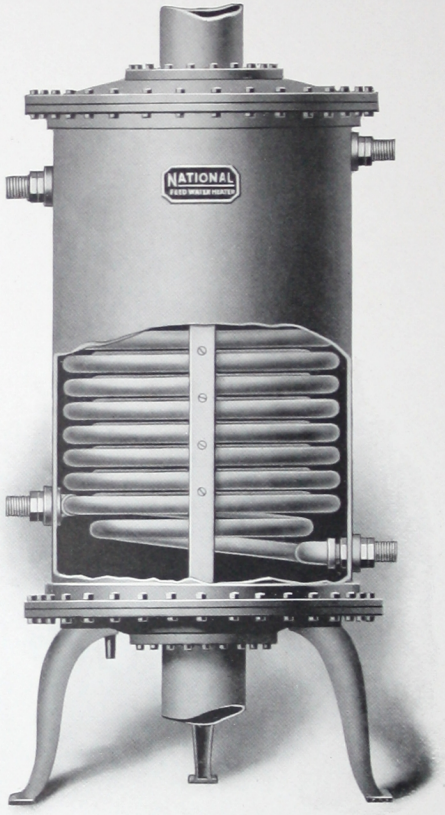
COILS

For Outside Header Type



COIL SUPPORTS AND BRACING

Outside Header Type



NATIONAL
FEED WATER HEATER
Double Coil

DOUBLE COIL HEATER

Under most conditions the amount of heat in the exhaust steam is more than sufficient to heat all the feed water to 210 or 212 degrees. The excess exhaust steam is thrown away, and there is no use for it. If, however, hot water is wanted for washing or bathing, it may be had without cost and from the same heater that heats the feed water.

Two Temperatures from one Heater

The National Double Coil Heater has two independent and separate feeds, one to supply the boiler with water at about 210 degrees, and one for connection to any tank or washing machine requiring large quantities of hot water. There is no interference whatever, the feed water inlets and outlets are independent. It is practically two heaters in one shell, occupying the space of a single heater.

Separate Coils

Two Heaters in One

REHEATERS

The National Heater may also be used as a reheater, placed between the high and low pressure cylinders of compound engines. Live steam is passed through the coils; and the steam, exhausted from the high-pressure cylinder into the shell, is reheated before passing into the low-pressure cylinder.

The National as a Reheater

RATING OR CAPACITY OF CLOSED FEED WATER HEATERS

In determining the size of a heater for a power plant, it is boiler horse power, not engine horse power, that should be considered, because it is to the boilers that the heater furnishes water. An engine horse power may require, and often does require, only about one-half as much steam per horse power as the boiler.

Horse-power Rating

It has been the custom to allow one-third of a square foot, or 48 square inches of coil heating surface per boiler horse power. This rating, however, is merely nominal, it might even be called arbitrary; for it does not take into account the velocity of the water through tubing, and every engineer knows that the greater the velocity the larger the amount of water heated, provided, of course, that there is plenty of steam. Again this rating does not take into account the temperature of the entering water.

"National" Experiments

Experiments extending over long periods, and made on many of our heaters, prove conclusively that these heaters can easily double their horse-power ratings when the water is pumped rapidly through them. It now seems better to list heaters by their heating surface—a known quantity.

Rating by Heating Surface

For this reason, it is advisable when asking for prices to specify the amount of water to be heated and the initial and final temperatures.

BRASS *vs.* COPPER COILS

The engineering public has been urged to purchase closed heaters having copper coils, for the claim has been made that copper conducts heat more efficiently than brass, and that a copper coil heater needs to have only about nine-tenths as much heating surface as a brass coil heater for the same heating capacity. Theoretically this is correct, but heater practice does not show a material difference in transmission between copper and brass coils, and even such authorities as professors in technical schools state that it makes no practical difference whether the heater has a copper or brass coil.

Brass Coils Good as Copper

NOTES ON ERECTION

Water Connections

The National Closed Feed Water Heater, vertical type, should be located as near the engine cylinder as possible and should, of course, be set vertically. As this type of feed water heater must be placed between the pump and the boiler, so that the feed water will be pumped through the heater, the lower end of the heater coil which passes through the shell is usually connected to the feed water pipe from the pump, and the upper end is connected to the pipe leading to the boiler. It is customary to pipe the cold feed water to the lower coil connection and take the hot water from the upper outlet of the coil, but this may be reversed if desired.

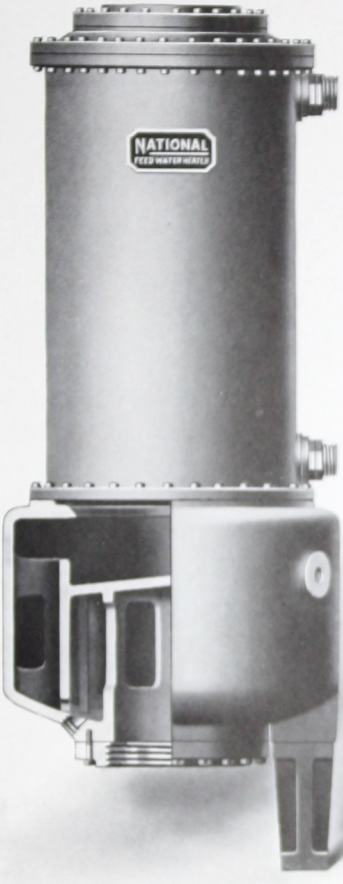
Steam Connections

The exhaust from the engine may be admitted at either top or bottom, whichever is more convenient or less expensive. The steam piping from the heater can be so arranged that any steam not used in heating the water can be conducted to a heating system or piped to an exhaust head.

Drip

The drip pipe at the bottom of the heater should always be open. It allows the condensed steam to leave the heater. The size of the drip pipe should never be reduced, nor should there be a valve in the pipe unless the heater is to be used in connection with a condenser.

If, however, the vertical type heater is to be set horizontally, this fact should be stated when ordering.



NATIONAL
FEED WATER HEATER WITH
OIL SEPARATOR

NATIONAL HORIZONTAL OIL SEPARATORS

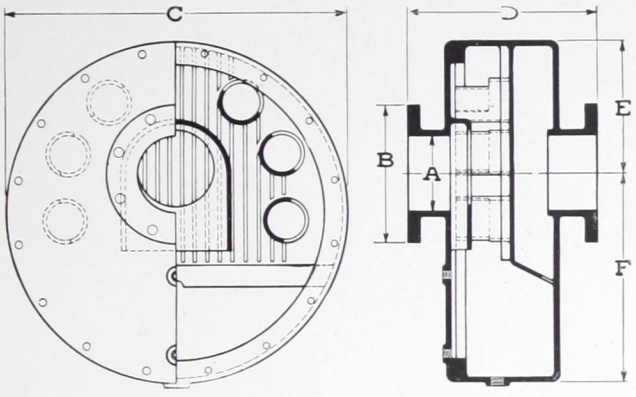
This relatively new type of oil separator completely removes all oil from exhaust steam, making it suitable for use in ice-making, heating, and drying systems, and various industrial processes.

The entering steam impinges on the main baffle which extends the full width of the separator; but side travel is prevented by vertical ribs. Ports in this baffle, having an area 1½ times greater than that of the inlet, allow steam to pass through the separator without adding to the back pressure on the engine. Each of these ports has an individual baffle in the form of a tube open on the back side, as shown in cut. These individual baffles and the arrangement of ports form the distinctive feature of the National Oil Separator.

Patented May 21, 1912

These separators are made in two pieces to allow inspection and test of baffle plates, and insure perfect castings. The joint is machined and guaranteed perfectly tight.

PRINCIPAL DIMENSIONS
NATIONAL
HORIZONTAL OIL SEPARATORS



ALL DIMENSIONS ARE IN INCHES

A	B	C	D	E	F	DRIP
3	$7\frac{1}{2}$	16	11	$6\frac{1}{2}$	$9\frac{1}{2}$	$\frac{3}{4}$
$3\frac{1}{2}$	$8\frac{1}{2}$	18	$11\frac{3}{4}$	$7\frac{1}{2}$	$10\frac{1}{2}$	$\frac{3}{4}$
4	9	20	13	8	12	1
$4\frac{1}{2}$	$9\frac{1}{4}$	22	$13\frac{3}{4}$	9	13	1
5	10	24	$14\frac{1}{2}$	$9\frac{1}{2}$	$14\frac{1}{2}$	1
6	11	27	15	$10\frac{1}{2}$	$16\frac{1}{2}$	1
7	$12\frac{1}{2}$	29	16	$11\frac{1}{2}$	$17\frac{1}{2}$	$1\frac{1}{4}$
8	$13\frac{1}{2}$	31	17	$12\frac{1}{2}$	$18\frac{1}{2}$	$1\frac{1}{4}$
10	16	35	19	$14\frac{1}{2}$	$20\frac{1}{2}$	$1\frac{1}{2}$
12	19	39	21	$16\frac{1}{2}$	$22\frac{1}{2}$	$1\frac{1}{2}$
14	21	43	23	$18\frac{1}{2}$	$24\frac{1}{2}$	$1\frac{1}{2}$
16	$23\frac{1}{2}$	48	25	21	27	$1\frac{1}{2}$
18	25	54	$26\frac{1}{2}$	$23\frac{1}{2}$	$30\frac{1}{2}$	2
20	$27\frac{1}{2}$	60	29	26	34	2
24	32	72	$31\frac{1}{2}$	31	41	2

Water Gauge Fittings and Drip Valve are Furnished with Each Separator but no Companion Flanges. Flanges are Faced and Drilled A. S. M. E. Standard unless otherwise specified.

We also build

NATIONAL

Direct-Contact (Open Type) Feed Water Heaters

NATIONAL

Hot Water Heaters for all purposes

NATIONAL

Oil Separators

COILS AND BENDS

Of all kinds

Water Inlet and Outlet Pipes
Gas and Exhaust Manifolds, etc.
for Gasolene Motors

Write for Catalogs.